P001

The Development of Competencies for Engineers within a Global Context

Malcolm Allan m.allan@gcal.ac.uk, Colin U. Chisholm c.u.chisholm@gcal.ac.uk

Glasgow Caledonian University UK

Abstract: *Engineering organisations are increasingly under pressure to perform more efficiently with less people. To manage this structure, organisations need to understand what skills, knowledge and behaviours it needs from engineers who have to increasingly practice within a global information society. Engineering educators today and tomorrow now need to think of how to place competencies for engineers in the context of operating within a global information society. A model for preparing the educators to face this challenge is proposed within the paper. This takes into account the change in mindset required to address the development of competencies for engineers where often the approach has to be context driven to address working globally. The model is based on developing a methodology by which a set of learning outcomes supported by aims and objectives may best be achieved. These learning outcomes are informed by the consideration of international frameworks and agreements which specify engineering professional competencies together with the corresponding graduate attributes. The core concept of the model is discussed and related to specific outcomes for educators to facilitate and students to achieve. While consideration is given to what competencies are needed for tomorrow's engineering education, it is concluded that more relevant is the need to reconsider existing competencies within the context of engineers being in global practice. This will require that educators need to be more responsive and be prepared to support the development and evolution of competencies that are sustainable and robust within global sociological, political and economic systems.*

Keywords: Global Engineering Competencies, Intercultural Competence

1. INTRODUCTION

Over the last ten year period there has been an increasing awareness across engineering and technology of the importance of recognising that the practice of engineering increasingly transcends national and cultural boundaries. Anecdotal evidence now shows that combining global competencies with technical education makes engineering graduates much more acceptable to the job market. In this respect it essentially enhances their employability. As early as the year 2000 the whole issue was raised by the American Society of Mechanical Engineering's Committee on Issues Identification [1]. It is interesting to note the flavour of their thinking where it is commented, 'The economics of nations are becoming increasingly interconnected. Information technology and knowledge cross borders through international telecommunications and on-line services. Computer-based engineering work is handed off around the world. Business, R&D, design, manufacturing, marketing and distribution are going global and engineering and engineering standards must go with them.'. The Committee further recommended that the profession 'test people for comfort and confidence in working with cross-cultural engineering teams particularly within new joint ventures and alliances that match up companies from different cultures'.

Evidence is also reported [2] to show that engineering graduates with cross-cultural global experience are much more tolerant in dealing with cultural differences which they encounter. Despite this far sighted evidence and other similar global anecdotal evidence of the value of developing global engineering competencies, engineering as a profession has been slow to address the need to accommodate global competencies as essential to the formation of the 21st century engineer.

While the recognition of competencies in engineering is relatively new, educators for some time have recognised the need for skills to be included in the curriculum. The concept of competence as an approach has grown significantly over the last decade and it is now well accepted that competence involves the use of knowledge and skills with ability to practice. More recently competence has been taken to include tacit as well as explicit knowledge in terms of translating learning into practice. Engineers live and practice in transdisciplinary environments which are very different from developing knowledge and skills in classroom / laboratory environments. Thus there is already a serious mismatch in terms of educating engineers in a range of relevant competencies for practice in organisations. The rapid development of a global information society now means that engineers not only have to operate within a complex and dynamic transdisciplinary environment within their organisation, but they more often now have to operate within a transglobal environment where specific contextual issues can dominate in terms of successful working practice. Thus educators now face a difficult task of looking at how to contextualise the learning to achieve more complex competencies which support practice within a rapidly changing global information society [3]. This means the educators must be prepared to emphasise theoretical principles in relation to student centred learning such as contextual learning (situated learning) [4] [5] and work based learning [6] [7] [8]. For this form of approach the learning motivation is mainly achieved by relating engineering technical knowledge to its application. While basic technical knowledge can be taught effectively in any programme in any country, once the knowledge is placed in a contextual environment the situation becomes much more complicated. For example an engineer while being technically competent and able to interpret knowledge in the context of the country and environment in which he/she is operating; may also find that when taking forward the application of the same technical knowledge in another part of the world that the significantly changed context makes it impossible to implement the technical knowledge. Educators need to be prepared for this type of approach to achieving sustainable competencies. It will not be possible for engineering educators to prepare students for all contextual situations which they will face in practice but they will be able through approaches such as project based, problem-based and work-based learning [8] [9] to prepare students to move forward in their careers within the concept of sustainable competencies which are contextually driven according to the global environment. In this respect engineers will be taught the vital importance of sustaining their profile of competencies by being careful reflective practitioners [10] in relation to operating across a range of global environments.

Thus with the rapid pace of change of technology, society and demographics, engineering educators are now faced with the challenge of examining the package of knowledge, skills and abilities which future generations of engineers will need to survive and succeed in the rapid globalisation of life in the 21^{st} century.

2. PROFESSIONAL ENGINEERING COMPETENCIES

There are a range of national and international agreements and frameworks which specify the required competencies of the professional engineer and in some cases those associated with the graduate from an accredited programme. In the USA for example global competencies form an important component of accredited engineering programmes in accordance with the Accreditation Board of Engineering and Technology (ABET). The educational focus on achieving outcomes that demonstrate competence in technology, communication skills and multidisciplinary teamwork [11]. Achievement of these competencies provides the means by which an individual can gain national and/or international recognition of their fitness to practice as a professional engineer, although very few countries enforce this within their regulatory and/or legal framework. However, international agreements such as the Washington Accord (WA) [12] seek to facilitate the international recognition of individuals who have demonstrated the achievement of nationally defined competencies, such as the UK Standard for Professional Engineering Competence [13]. These international agreements are generally confined to the recognition of the signatories to the agreement although this includes most of the worlds ‘developed’ countries. Clearly, one might expect that these agreements should facilitate the mobility of the professional engineer and graduate across national boundaries. However, this implies that there needs to be some convergence or equivalence in the competencies specified and that these include a context which facilitates global and intercultural working. It is therefore useful to examine these nationally and internationally agreed competencies for convergence/equivalence and also the contribution they might make for effective global working.

There are two main international systems for professional engineers’ registration, Engineers Mobility Forum (EMF) (associated with the International Professional Engineer (IntPE)) and the European Federation of National Engineering Associations (FEANI) (associated with the European Engineer (EurEng)). The standard route to IntPE would be a 4-yr accredited Bachelors (US) degree followed by 7 years experience and for EurEng an accredited first cycle qualification (as defined by Bologna [14]) followed by 4 years experience. The professional competencies specified by the two systems are broadly equivalent [15] [16]. In the context of the contribution the formal education element makes to this formation reference can be made to the respective ‘Graduate Attributes’ specified by the EMF [15] and EUR-ACE (EURopean ACcredited Engineer) [17]. These are presented in Table 2.1.

Clearly, in broad terms the WA/EMF and EUR-ACE attributes are comparable although EMF attributes in the area of Modern Tool Usage and Individual and Team work are enhanced in comparison with EUR-ACE. However, when second-cycle EUR-ACE attributes are considered it is clear that all the attributes are extended and/or taken to a higher level. For example, there is no expectation under the first cycle for the graduate to possess the attribute to work and communicate effectively in national and international contexts. This is made explicit as a second cycle attribute.

WA/EMF Attributes	EUR-ACE Attributes
Knowledge of Engineering Sciences	Knowledge and Understanding
Problem Analysis	Engineering Analysis
Design/development of solutions	Engineering Design
Investigation	Investigations
Modern Tool Usage	Engineering Practice
Individual and Team work Communication The Engineer and Society Ethics Environment and Sustainability Project Management and Finance Life long learning	Transferable Skills

Table 2.1 Engineering Graduate Attributes – EMF v EUR-ACE

The above comparison leads to the conclusion that both systems should facilitate broadly compatible engineering graduates who therefore should be able to contribute as engineers within an international arena (i.e. on the basis that the competencies and attributes are equivalent). However, these attributes do not place any emphasis on the international/global context within which the attributes are achieved or developed – there is no explicit mention of cultural issues within the first cycle EUR-ACE specification. Although, it is observed that second cycle programmes do appear to acknowledge this through enhancing the transferable skills element. In the UK an integrated first/second cycle programme (MEng) is the benchmark qualification for the academic formation towards a chartered engineer. A more robust conclusion is that the current international systems of mutual recognition of engineering education requirements do not guarantee that a graduate possesses the necessary attributes to work effectively within a global/international environment.

It is therefore necessary to establish specifically the competencies required for effective working within an international arena and how these might best be developed.

3. GLOBAL COMPETENCIES

So what competencies are required to facilitate and enhance an engineer's personal and professional development and involvement within the context of multicultural and diverse global environments?

Engineers will need to:

- Take forward and embrace a personal ethic of social responsibility and service within the community based environments which are racially, culturally, ethnically and linguistically different from their own.
- Practice culturally appropriate relationship centred involvement within the global environments in which they work.
- Use communication and information technology that can deliver information to communities of practice who are from diverse racial, ethnic, religious, cultural and linguistic backgrounds.
- Provide leadership that is totally inclusive of ethnic and cultural backgrounds and supports shared decision-making.
- Be able to work on as a team member within inter-and transdisciplinary systems where diverse ways of thinking, being and doing are the basis of practice.

- Show ethical behaviour in all aspects of practice, both personal and professional which involves individuals from diverse global backgrounds.
- Show empathy with all diverse communities and individuals affected by engineering decisions taken in any given situation or environment.
- Consider for planning, developing and generating engineering products and services the value and need to incorporate the determinants of global based views regardless of ethnicity, culture or race.
- Actively support and promote education and learning to improve the well being of a global society.
- Ensure that all interpersonal interactions in the job role and in other lifeplaces are competent and effective within the context of linguistic, racial, ethnic and cultural differences.
- Incorporate fundamental consideration of relevant aspects of cross-cultural diversity into critical thinking, reflective analysis and problem solving in engineering.
- Support within their job role culturally aware developments and practices alongside ensuring inclusion and participation of communities of practice which reflect ethnic, racial and linguistic diversity.
- Continuously review and improve cultural competence at the personal and professional levels and within the organisational systems through the engineering job role
- Within global working be prepared to deliver product development and engineering systems which are culturally appropriate and meet the needs of a diverse global community.
- In decisions and in delivering engineering practice ensure a balance of consideration at individual, professional, system and global societal needs.
- Show entrepreneurial behaviour in all aspects of practice within the context of social responsibility and social justice.
- Embrace philosophy as a pursuit of wisdom in a Global context.

The creation of the global society that is now taking shape is both an enormous challenge and an unprecedented opportunity for the engineering profession and the engineering educators. Co-operative engineering product development, research and delivery of engineering systems depends now on a global network which needs co-operation across many cultures, disciplines and communities. This co-operation depends fundamentally on partners understanding each other’s competencies within a global societal context. Today global organisations can be successful if their engineering research departments can transform innovative ideas into new products more quickly and with less expense than their competitors. Global team building and working in global teams will facilitate achieving this, but global teams need their technical competence to be integrated with the global competencies discussed to achieve the contextual approach needed to survive in the global information society. Quite apart from this, globally networked research can create a potential global knowledge base where complex competencies can be made available at a rapid rate. Thus these competencies can nucleate co-operation and understanding across different cultures, disciplines, races and languages where the communities of practice are competent to deliver technically while exercising mutual respect and understanding of global diversity. This is the challenge facing engineering educators who need to develop approaches to achieving the next generation of sustainable global competencies. So the educators need in depth skills to drive these global competencies into place in programmes.

4. PROGRAMME FOR THE EDUCATORS

To educate the educators in developing competencies within the context of the global information society some form of aims and objectives are required. The following are proposed for the educational model.

- To develop an in depth critical understanding of how to take forward competencies which take into account race, culture, ethnicity and language / communication.
- To establish an in depth ability to use current theories and methodologies for the analysis of existing competencies and the development of future global based competencies.
- To establish an ability to analyse and use methodologies relating to competence specification for global ethicalness, law and risk in engineering policy and practice.

To ensure educators can deliver an understanding of this profile of competencies overall outcomes need to be put in place. The following are proposed for the educational model where it is anticipated that educators will need to clearly demonstrate the outcomes have been achieved if engineering students are to move forward with competencies, which are set in the context of the evolving global information society. They are:

- Be able to complete in depth analysis and education of the relationship between existing and new engineering competencies in the context of race, ethnicity, culture and language.
- Be able to use theories and methodologies for the analysis of current and future competencies relevant to engineering.
- Be able to contextualise competencies in relation to ethics, law and risk for engineering practice.
- Be able to develop organisational competencies relevant to engineering in the context of ethnicity, culture, race and language.
- Evolve lifelong sustainable global competencies for engineers.
- Be able to evolve new competencies relevant to engineering which show empathy with culture, race and ethnicity.

To achieve the desired outcomes educators will require to follow a systematic programme designed to educate the educators. To initiate the studies a review will be required of the status of the existing range of competencies relevant to the various levels of engineering qualifications as outlined in Section 2 of this paper. In particular, knowledge, skills and context will need to be examined for the existing range against the context of culture, race, ethnicity and multicultural systems of social, political and economic order. Educators will need to be able to carry out a critical evaluation of the existing range of competencies and be able to decide what new competencies need to be developed to address operation in a global information society. In particular the existing range of competencies will need to be critically reviewed to decide whether they can be further developed into the global information context. To support this approach educators will need to be able to use up to date methodologies related to the design of global based competencies. They will need to build competency models which are based on knowledge which supports an awareness and understanding needed to live and practice engineering in a diverse global environment. This will involve evolving a model which underpins competencies as sustainable, lifelong and transferable within the world of multicultural diversity. Not only will explicit knowledge be needed but this will need to be integrated with tacit knowledge which supports the understanding of how global diversity affects the development of relevant competencies. Thus educators will need to clearly understand the value of tacit knowledge in relation to ethnicity, culture and race. This is a complex area which will provide challenge to engineering educators but nevertheless is an essential component of the engineering curriculum, if competencies which are representative of a global information society are to be successful drivers for engineering in society. Thus educators will have to clearly understand how to integrate tacit and explicit knowledge inputs into the competency development models being evolved. Closely linked to global diversity is ethicalness and how this is interpreted in a global information society. This is an area of essential competence which educators will need to develop by analysing the scope and context of ethics in global engineering practice. Codes of ethics related to culture, ethnicity and race across a diverse world environment will need careful consideration if an appropriate competence is to be developed. Educators will need to learn how to scope the competence related to whatever ethical practices are relevant to the geographical area in which engineering is being practised. It will not be possible to cover the whole range of aspects relevant to ethical competence and thus educators will need to understand the importance of producing case studies which illustrate the importance of interpreting ethics in the context of the environment in which engineering is being carried out without the necessity to cover the whole range of codes of ethics which exist across the global environment. In this respect the roles of the educators will be to alert students to the need to be prepared to develop their competencies and sustain them by awareness and understanding of the interpretation of ethics in the context of a given geographical practice based environment. Thus educators need to develop abilities to put in place illustrative case studies which clearly show technical competence has to be delivered through a more complex approach where technological solutions are presented within the context of considering culture, ethnicity and race alongside the codes of ethics which apply. Educators have a key task in interpreting the composite nature of such competencies to engineering students. Other aspects which will need careful consideration are inputs such as legal, safety and risk. Again educators will need to identify the knowledge required to support competencies which have such inputs. This will be best achieved by a case study approach which facilitates the analysis of required legal, risk and safety issues to be considered in the context of world diversity. Lifelong sustainable competencies will demand inputs related to creativity, innovation, entrepreneurship, problem solving, reflection, change management, leadership and the attributes associated with emotional intelligence. Educators will need to understand that these competencies again will need to be placed in the context of diverse geographical environments.

5. DISCUSSION

It has been shown that global multicultural competency is a key direction which engineering educators must now take as engineering graduates increasingly have a career in the global information society. This means educators have to clearly understand the knowledge, skills and personal attributes which the students need to develop to work in a diverse world.

So accepting that the engineering technology inputs are well understood in the engineering curriculum what are the knowledge, skills and personal attributes which are needed as inputs to create sustainable competencies which account for practice across the emerging global information society? Essential is a working knowledge of diverse ethnic groups and their associated cultures particularly in relation to inputs such as ethics, risk and safety. As was mentioned earlier another essential aspect is a knowledge of social, political and economic issues and how these issues impact on race and ethnic relations across the global world. Above all it is clear that educators have a prime responsibility for teaching the diversity implications for personal and career development. This approach is validated by Hofstede [18] who proposes that the acquisition of intercultural communication abilities passes through three phases, namely: awareness, knowledge and skills and Jansen [19] proposes that this could be implemented through two modules, one on Cultural Awareness and one on Intercultural Categories. Jansen [19] also strongly supports the case study problem solving approach advocated here.

What are the key aspects which educators need to develop with students? First and foremost engineers need to have flexibility to respond to and adapt to new and changing global environments. Respect and values which take account of cultural diversity and ethics are also an essential attribute. Emotional intelligence also has a key role in terms of developing empathy with other races and other cultures by listening and understanding their perspective. The third input involves key skills to underpin specifically living in a diverse global society. Above all is cross cultural communication involving verbal and non verbal communication skills. No matter how good an understanding an engineer has of the engineering technology, its implementation and successful development is directly related to competence in multicultural communication.

While entrepreneurial behaviour is highly important it is essential for global competence that it is set in the context of social responsibility and social justice if proper account is to be taken of cross-cultural and environmental issues [20] [21]. While perhaps not immediately obvious the embracement of philosophy will support a value approach to practice within the global information society. Currently the majority of engineering graduates become involved with the technology development while completely ignoring philosophical analyses. With competence in philosophy supporting continuous re-examination of assumptions made in a given problem solving situation it supports engineers achieving more novel solutions acceptable in a multicultural global environment. Combined with the entrepreneurial approach it could lead to a new generation of engineers who can take a more novel approach to solving globally based intractable problems.

The authors were involved with a Framework 6 project operating across Europe where a multidisciplinary team of educators from six countries contributed to a key aspect of the project which involved examining how to develop engineering competencies against an evolving global information society [22].This project was completed at the end of 2005 and the initial results have continued to be extended by the authors. One of the essential conclusions reached during the studies was that the competency development in the context of a global information society was probably best achieved using a team development approach involving the disciplines of social sciences, educational studies, and business studies inclusive of aspects of law, risk ,economics and ethics. In another European project relating to competency development through work based learning it was also concluded that while specialist inputs could be used from other disciplines the teaching should be co-ordinated and led by professional engineering educators trained as described earlier in the paper. Conflicting views were held as to the level of input from specialists with a range of views which supported the teaching being entirely engineering led to various levels of support from subject experts [23].The authors in collaboration with others have been involved for a number of years in the development and operation of engineering led team teaching relating to multidisciplinary aspects of a number of engineering degrees [24] [25] [26]. They have also successfully developed transdisciplinary work based postgraduate degrees and reported on the success of these developments showing how competencies are effectively developed through structured workplace learning [27] [28] [29].On the basis of previous work it is anticipated that a successful model for competency development in the context of a growing global information society can be put in place using a similar approach to earlier developments of engineering competencies where inputs from other relevant disciplines and the use of off-campus learning environments have proved to be a useful way forward.

Ethics for engineers in terms of global competence has been reported as a successful development in New Zealand, followed by successful delivery in Australia and Germany [30] [31] [32].This work, which has clearly been successful, was essentially an example of an engineering led development in terms of both the development stage and the subsequent teaching using a novel problem solving approach. Clearly this example illustrates that engineering educators can effectively become multi-skilled as was discussed earlier in the paper and this offers an alternative approach to using a multidisciplinary team of educators to develop and/or provide the teaching. This is an area which will no doubt lead to healthy debate with regard to future developments.

Another interesting example relating to Aeronautical Engineering involved students developing global thinking and learning how to practice in a multicultural environment by spending a semester in another European country. While the scheme was limited to Europe it was claimed to develop an international outlook in students and again this approach was primarily engineering led [33]. Further evidence of the value of industrial-based methods for MEng education is described where competencies are claimed to be effectively delivered based on tacit knowledge which can only be effectively integrated in a transdisciplinary workplace environment [34].This is very much in line with the authors' views where tacit knowledge is considered to be core to the success of global competency development.

On this basis of this discussion it can be seen that multicultural teamwork is most probably a key development which the educators must achieve, as within the global information society it is teamwork regardless of race, ethnicity or culture that is a key driver in seeking effective engineering solutions. Understanding diverse perspectives is also a key component alongside being able to provide leadership to a multicultural group. Educators can best develop awareness and appreciation of cultural differences across the world by taking a case study problem solving approach [6] and as a starting point have students seriously examine their own cultural background and how that has shaped their attitudes and opinions. In educating the educators again this would form a useful case study approach for their development. The global case study approach has been shown by some educators [2], [11] to be highly successful in developing student focus on alternative socio-technological and politico-economic models of development which are set in the context of social responsibility.

6. CONCLUSIONS

- Multicultural competency development for engineers is now essential if future generations are to be effective in the global information society.
- Engineering educators need to be trained and developed to teach an understanding of competencies in the context of a global information society.
- A model is described for the approach to global competencies that takes account of race, ethnicity, culture, and language.
- An approach to educating the educators on how to teach global competencies to future generations of engineers is proposed.
- The establishment of multicultural competencies will lead to a new generation of graduates who will enter the workforce with an enhanced vision of the global social and environmental implications of technology and the

implications that technological advances have in terms of the sustainable global society.

- The model can be based on a teamwork approach where relevant disciplines contribute to the development of the competencies and the teaching can be team taught or engineering led.

REFERENCES

[1] Committee on Issues Identification, "Issues of Concern to Engineers", ASME International, http://www.asme.org./coii/isslst.html (2001).

[2] Herling, D., Herling, A., and Peterson, J., Integrating Engineering and Global Competencies: A Case Study of Oregon State University's International Degree Program, 31st ASEE/IEEE Frontiers in Education Conference, October (2001).

[3] Chisholm, C. U., Educating the Engineering Educators on the Development of Competencies for a Global Information Society, 9th UICEE Annual Conference on Engineering Education, Muscat, Oman, (2006).

[4] Lave, J., and Wenger, E., Situated learning, Cambridge Un. Press, (1991).

[5] Kolmos, A., Future competencies and learning methods in engineering education, Proc. 6th Baltic Region Seminar on Engng. Edu., Wismar, Germany, 1-4, (2002).

[6] Burns, G.R., and Chisholm, C.U., Graduate to professional engineer in a knowledge organisation: does the undergraduate curriculum provide the basic skills? Proc. 8th UICEE Annual Conf. on Engng. Edu., Kingston, Jamaica, 37-40, (2005).

[7] Chisholm, C.U., Holifield, D.M., and Davis, M.S.G., The development of a model based on learning development agreements for the professional development of engineers, Proc. 8th UICEE Annual Conf. on Engng. Edu., Kingston, Jamaica, 37-40, (2005).

[8] Chisholm, C.U., Negotiated learning systems – a way forward for engineering education, Proc. 1st North-East Asia International Conf. on Engng. and Tech. Edu., Taiwan, 346-354, (2003).

[9] Gruff, E.D., and Kolmos, A., Characteristics of problem-based learning, Inter. J of Engng. Edu., (2002).

[10] Wenger, E., Communities of Practice – Learning, Meaning and Identity, Cambridge. Un. Press, (1998).

[11] Tharakan, J., Castro, M., Trimble, J., Stephenson, B.A., and Verharen, C.C., Diversifying Engineering Education: A Seminar Course on the Ethics and Philosophy of Appropriate Technology, Proc. of 8th UICEE Annual Conference on Eng. Edu., Kingston Jamaica, 85-90, (2005).

[12] Washington Accord, Recognition of Equivalency of accredited Engineering Education Programmes leading to the Engineering Degree, www.washingtonaccord.org/, (established 1988).

[13] UK Standard for Professional Engineering Competence, Engineering Council, UK, www.engc.org.uk, (2004).

[14] A Framework for Qualifications of the European Higher Education Area, ISBN (internet) 87-91469-53-8, www.bologna-bergen2005.no, (2005).

[15] Graduate Attributes and Professional Competencies, Engineers Mobility Forum, Ver. 1.1, www.ieagreements.com/GradProfiles.cfm , (2005).

[16] Competencies of Professional Engineers / Eur Eng, European Federation of National Engineering Associations (FEANI), Belgium, (2005).

[17] Framework Standards for the Accreditation of Engineering Programmes, European Accredited Engineer, www.feani.org/EUR_ACE/reports_accrstand.htm, (2005).

[18] Hofstede, G., Cultures and Organisations: Software of the Mind (2nd edn), New York: McGraw Hill (1997).

[19] Jansen, D. E., Developing the intercultural competence of engineering students: a proposal for the method and contents of a seminar, World Transactions on Engineering and Teaching Education, Vol.3, No. 1, UICEE, (2004).

[20] Chisholm,C.U., and Blair M.S.G., The role of entrepreneurship as an engineering competence in a global information society, Proc.10th Baltic Region Seminar on Engng. Educ., Szczecin, Poland, 38-41 (2006).

[21] Temple, B.K., and Chisholm C.U., The role of entrepreneurship in the engineering curriculum, World Transactions on Engineering and Technology Education, Vol. 1 no 1, 75-79 (2002).

[22] Socrates Programme, Erasmus projects, Grant Agreement No 29075-1C-1-2002-DK. Erasmus –Proguc -1 (2003-2005).

[23] Fink, F.K., Chisholm, C.U., Norgaard, B., and Blair, M.S.G., Continuing engineering education as work based learning –results from an EU Leonardo Project, Proc. of International Conference on Researching Work and Learning, Sydney, Australia (2005).

[24] Burns, G.R., and Chisholm, C.U., Factors to be considered in developing a curriculum and assessment for a knowledge based engineering graduate, Proc. 4TH UICEE Annual Conference on Engng. Educ.,Bangkok, Thailand,196-201 (2001).

[25] Chisholm, C.U., Holifield, D.M., and Davis, M.S.G., The development of a model based on learning agreements for professional development of engineers, Proc.8thUICEE Conference on Engng. Educ., Kingston, Jamaica, 143-147 (2005).

[26] Burns, G. R., Chisholm, C.U., Blair, M.S.G., Holifield, D.M., Clarke, T., A case for professional development for employability, International J. Tech.and Engng. Educ. Vol 3, No 2, 53-59 (2006).

[27] Burns, G.R., and Chisholm, C.U., Some observations on assessment of experience led or workplace learning in higher education, Proc. Work Based Learning Network of Universities' Association for Lifelong Learning, Edinburgh, Scotland, 101-110 (2005).

[28] Chisholm, C.U., and Burns, G.R., Development of an engineering doctorate learning contract framework using work based learning, Proc.1st UICEE Annual Conference on Engng. Educ. Melbourne, Australia (1998).

[30] Buckeridge, J.S., and Grunwald, N., Ethics and the Professional: A template for international benchmarking in engineering education, Global Journal of Engng. Educ., Vol 7, No 1, 51-57 (2003).

[31] Buckeridge, J.S., Ethics and the Professional (2nd Edition) Auckland, New Zealand Lyceum Press (2002).

[32] Buckeridge, J.S., and Tapp, B.A., Interpreting the realities of ethics and sustainability within the Australian context. Trans. Inst. Professional Engineers, New Zealand, 27, 1, 17-20 (2000).

[33] Sterling, S. G., Price, M., Gibson, A., and Bernard, E., A Semester Abroad Scheme for stage 4 Aeronautical Engineering MEng students. Global Journal of Engng. Educ., Vol7, No 1, 113-120 (2003).

[34] Short, T.D., Garside, J.A., and Appleton, E., Industry and the Engineering Student : A Marriage made in Heaven? Global Journal of Engng. Educ. Vol7, No 1, 77-85 (2003).

[35] Chisholm, C.U., The role of tacit knowledge in the continuous professional development of work based practitioners, Proc. Work Based Learning Network of Universities' Association for Continuing Education, Cyprus, 242-250 (2003)

Acknowledgement:
The authors developed these studies as part of a financed SOCRATES-PROGRAMME, ERASMUS projects 2003—2004.
Grant agreement no. 29075-IC-1-2002-DK-ERASMUS –PROGUC-1.